Factors that Influence the City of Seattle's Stormwater Management Program

The traditional approach of stormwater conveyance and storage (e.g., pipes and detention ponds) as a means to address flooding, while successful in addressing many problems related to public safety and property damage, has resulted in adverse impacts on the health of receiving waters (i.e. degraded habitat and water quality). Similarly, attempts to improve water quality through structural end-of-pipe technologies have been met with limited success. New innovations in stormwater technology are needed to address the water quality challenges associated with urban areas. Some of the factors that have influenced the direction of the City of Seattle's Stormwater Management Program are listed below.

- Seattle has a population of approximately 560,000 people living in a very urban landscape. The density of below- and above-ground infrastructure including buildings, parking lots, roads, utilities, and communication systems results in limited space for traditional stormwater management techniques such as detention ponds or underground vaults.

- Seattle is nearly 150 years old. Much of the city was developed before water quality regulations were in place and consequently, little to no treatment was included as properties were developed to the density that exists today. The average parcel size is small (approximately 5000 sq. ft) and the rate of redevelopment is very low- <1% year. Because of this, local redevelopment regulations can only provide a partial answer to addressing water quality and flow management concerns.

- There is a great diversity of water body types associated with Seattle including Lake Washington, Lake Union, Puget Sound, Duwamish River, small lakes (i.e., Green, Haller and Bitter Lakes) and numerous streams. While these systems are impacted by similar water quality problems that might be expected in an urban area, the different ecological processes that govern these systems as well as the varying land use issues creates a challenging problem when attempting to identify efficient and effective solutions.

- Approximately 25% of the total land mass in Seattle is in city, state and federal transportation corridors. The management of roadway runoff is an increasing focus area for Seattle, especially related to automobile sources of pollutants and their treatment. Seattle's Natural Drainage System Program is an example of an innovative program that uses a system of vegetated swales within the public right-of-way to treat road runoff and manage flows.

- The city is comprised of three different infrastructure types, each serving approximately 1/3 of the city. The combined sewer system carries both wastewater and stormwater runoff and terminate at one of the area's wastewater treatment plants. In large storm events, combined sewers may overflow into a receiving water body through a combined sewer overflow discharge point. In the separated system, wastewater goes to a sanitary sewer and storm drainage is directed to a separate storm drainage system. In partially separated sewer areas, rooftop drainage is generally directed to the sanitary sewer, while street runoff is directed to a separate storm drainage system. Lastly, the ditch and culvert areas of Seattle are a separated system where the stormwater runoff is managed primarily through a system of ditches and culverts. Most of the ditch and culvert areas drain to creek receiving waters. The complexity of the different infrastructure types and relationship to receiving waters

requires a tailored approach to stormwater management. What might work in one infrastructure and receiving water body type may not work in another- so each situation must be evaluated to identify appropriate solutions.

- Many of the small receiving waters like creeks are used as drainage corridors and suffer from adverse flow impacts like excessive scour and habitat degradation. Efforts to protect and improve creeks systems must consider the flow issues as well as water quality.

- Land use influences how stormwater management is implemented in Seattle. There are distinct industrial, commercial, and residential areas throughout Seattle. Creek watersheds are located in primarily residential areas of the city and citizen's actions have a direct impact to aquatic ecosystem health. Working to educate and change human behavior is a key focus in these creek watersheds. In the highly industrial areas such as areas adjacent to the Duwamish River and Elliot Bay, working with businesses on source controls, and best management practices are key in keeping pollutants out of the waterbodies. In addition, areas that were sites of historical industry now have left legacy contamination in the nearby sediments. The Duwamish River and Lake Union are two examples where sediment remediation is a key focus. Water quality solutions in the Duwamish basin are further complicated by tidal fluctuations that can cause flooding of low-lying land and related pipe systems.

- The technologies for treating conventional pollutants such as nutrient and metals have been increasing over the last decade, but there is no "silver bullet" treatment system that has been shown to remove the majority of pollutant to desired Water Quality Standards. In addition, the emergence of new pollutants, such as endocrine disruptors is a significant cause for concern. Many of the endocrine disruptors, for example, have been shown to have adverse aquatic and human health impacts but occur in concentrations so small that they are difficult to even detect, much less treat. Product management an increasing area of focus for Seattle as we attempt to keep pollutants out of the waste stream in the first place.

- Seattle is very environmentally conscious community. The public, local government, and elected officials are open to innovative and creative actions to protect and improve the environment. This has allowed Seattle to pursue cutting-edge pilot projects that have gained national recognition.

Seattle has chosen to emphasize a decentralized approach to stormwater quality management as the best means for protecting and improving its receiving waters. Unlike end-of-pipe treatment, decentralized stormwater management is based on using a variety of on-site opportunities within the watershed to reduce pollutants before reaching the receiving water. The objective is to keep stormwater pollutants out of the pipes in the first place by emphasizing interception treatment and source control. These approaches may include capital projects located within the public right-of-way designed to treat roadway runoff; private incentives to homeowners to amend their soils and thus increase stormwater infiltration ability; and education on environmentally-friendly products to keep harmful pollutants out of the receiving waters. Often decentralized stormwater management has ancillary social and economic benefits beyond meeting the water quality objectives, which are important considerations when striving for urban sustainability.